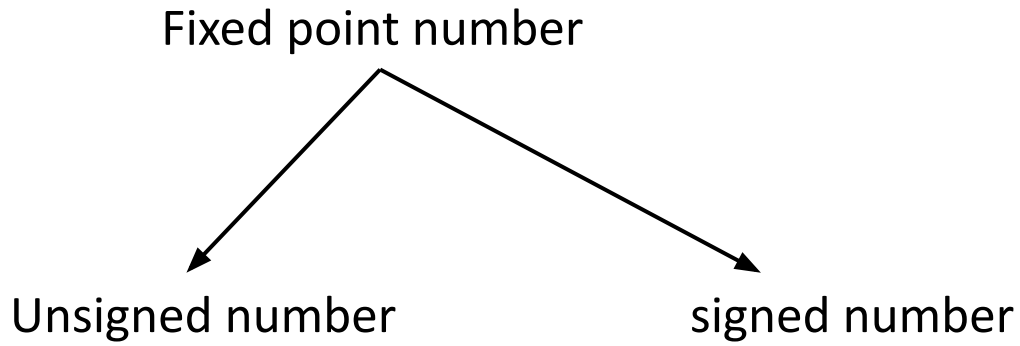
Fixed Point Number Representation



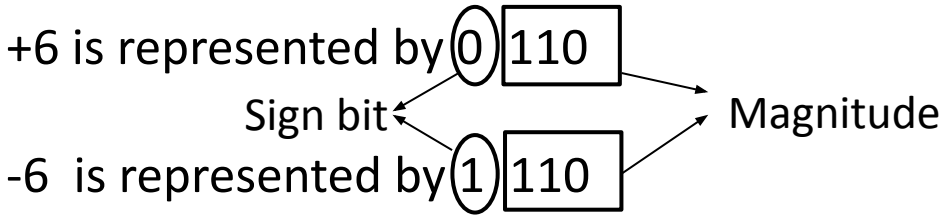
In case of unsigned number, the range of n bit number is
0 to $2^n - 1$
For 4 bit number the range is
0 to 15
For 8 bit number the range is
0 to 255

Signed number representation:

1. Signed-magnitude representation
2. 1's complement representation
3. 2's complement representation

Signed-magnitude representation

In sign magnitude representation, if the number is positive then sign bit is 0 and if the number is negative then sign bit is 1.



In sign magnitude representation, the range of n bit number is

$-(2^{n-1}-1)$ to $+(2^{n-1}-1)$

For 4 bit number the range is

-7 to +7

For 8 bit number the range is

-127 to +127

There are two different representation of 0 (+0 and -0).

4 bit representation of +0 is 0000

4 bit representation of -0 is 1000

1’s complement representation

In 1’s complement representation, Positive number is represented by same as Sign magnitude but negative number is the 1’s complement of positive number.

+6 is represented by 0 110

-6 is represented by 1 001

In 1’s complement representation, the range of n bit number is
$-(2^{n-1}-1)$ to $+(2^{n-1}-1)$
For 4 bit number the range is
-7 to +7
For 8 bit number the range is
-127 to +127
There are two different representation of 0 (+0 and -0).
4 bit representation of +0 is 0000
4 bit representation of -0 is 1111

2’s complement representation

In 2’s complement representation, Positive number is represented by same as Sign magnitude but negative number is the 2’s complement of positive number.

+6 is represented by 0 110
1’s complement of +6 is 1 001
-6 is represented by 1 010 (that is 1 001 +1)

In 2’s complement representation, the range of n bit number is
$-(2^{n-1})$ to $+(2^{n-1}-1)$
For 4 bit number the range is
-8 to +7
For 8 bit number the range is
-128 to +127
There is a unique representation of 0 (+0 and -0).
4 bit representation of +0 is 0000
4 bit representation of -0 is 0000

Arithmetic Addition

(+7) 00111
(+5) 00101

(+12) 01100

Arithmetic Subtraction using 2's Complement method

(+5) 0101
1's complement of +5 is 1010
2's complement of +5 is 1011

(+7) 0111
(-5) 1011

(+2) (1) 0010

carry bit

Incase of 2's complement carry bit will be discarded

Overflow in 2's Complement arithmetic

Perform the following calculation

Case1:

+4	0100
-7	1001
-3	1101

(+7) 0111
1's complement of +7 is 1000
2's complement of +7 is 1001

If the sign of operands are different then overflow never occur.

Case2:

-2	1110
-4	1100
-6	1 1010

(+2) 0010
1's complement of +2 is 1101
2's complement of +2 is 1110

(+4) 0100
1's complement of +4 is 1011
2's complement of +4 is 1100

Case3:

-5	1011
-6	1010
-11	1 0101

(+5) 0101
1's complement of +5 is 1010
2's complement of +5 is 1011

(+6) 0110
1's complement of +6 is 1001
2's complement of +6 is 1010

If the sign of operands are same then overflow may occur

In case2: the sign of both operands are negative and the sign of the result also negative

so here overflow is not occurred and the extra bit is carry bit. Discard the carry bit

In case3: the sign of both operands are negative and the sign of the result is positive.

so here overflow is occurred and the extra bit is taken under consideration

Thank You